Remarks

The Amendments to the Claims

Independent claims 1 and 13 are amended. Each claim specifies a "predetermining" step in which a preform shape is devised. The preform shape is a deformation precursor for a stamped aluminum alloy article. The preform shape is necessary because the article shape cannot be produced in a single stamping operation without exceeding the straining limit of the sheet material at some location in the article.

Claims 1 and 13 are amended to specify that the preform shape include at least one region that is to be strained up to, but not exceeding, the strain limit of the sheet material, and that the strain in such region is higher than in adjacent portions of the preform shape. The predetermining step also specifies that an annealing practice be devised for the highly strained region. The re-softened preform shape is then stamped in a second stamping operation into the article shape. This predetermining step is described in paragraphs 0005-0010 and paragraphs 0025-0029 of applicant's specification. Circled areas 54, 56, 58, 60, 62, and 64 in Figure 1B are areas of inner tailgate panel stamping 10 that cannot be formed in a single stamping step because the sheet metal would split or tear. The regions identified by the numerals are more highly strained than adjacent regions of the stamped part. And as stated in paragraph 0028, the preform shape was devised to "determine the deepest part possible without necking or tearing."

Claims 1 and 13 are further amended to make clear that the highly strained region(s) is strained and formed by stretching the sheet in contact with the punch and forming tool, as previously specified in the claims.

Claim 13 has been amended to delete the optional lubrication step (paragraph 0035).

The Claim Rejections

Claims 1-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Krajewski et al. (US Patent 6,038,911) in view of Biondich (US Patent 5,776,270).

The Examiner is respectfully requested to reconsider and withdraw the rejection of claims 1-14 for the following reasons.

The Claimed Invention

The invention, as recited in claims 1-14, pertains to stamping articles like automotive body panels from aluminum alloy sheet material. Inner and outer vehicle door panels and tailgate panels are examples of many stampings that are produced annually. The sheets are typically about 1 to 2.5 millimeters thick (paragraph 0018) and are formed at ambient temperature in a stamping press using tools comprising a punch and a concave cavity. The blank sheet is gripped at its edges and the tools are closed on the blank so that the punch pushes and stretches the aluminum alloy sheet into conformance with the opposing tool. It is preferred to stamp the blank into a final shape in one stamping step (except for possible trimming and piercing steps). A press and a single set of expensive stamping tools forms a body panel in a single cycle of inserting the blank, closing the press on the blank to stamp the panel shape, opening the press, and removing the formed panel. As stated in paragraph 0008, a typical panel stamping cycle is about ten seconds and the actual straining of the metal is accomplished in about one to three seconds. The stamping is accomplished quickly but not instantaneously.

It is desired to form body panels out of light weight aluminum alloys. But aluminum sheets are not as formable as steel, and many aluminum panel shapes cannot be formed in a single stamping step. The methods of claims 1-14 provide a way of forming such articles in two stamping steps with an intermediate anneal of highly strained regions. Independent claims 1 and 13 state generic methods. Dependent claims 2-4 state that the process is conducted in a continuous sequence of steps of substantially equal duration to facilitate efficient synchronous operation of the stamping and annealing stations in a manufacturing line. Dependent claims 5-8 state tempering requirements and dependent claims 9-12 and 14 specify a family of magnesium, containing aluminum alloys.

The panel to be stamped has a shape specified by a vehicle designer, but the metal stamping engineer has to determine how to make a good panel. A formable aluminum alloy is selected having a suitable thickness for the strength of the panel and having known stress/strain forming properties, including a straining-limit. These properties are evaluated by experiment or, more likely, by a computational model (paragraphs 0005, 0010-0011, 0028-0030), e.g., a finite element analysis method, to determine whether the article shape can be made in a single stamping operation. The shape cannot be made in a single stamping step if some portion of the

aluminum sheet will be stretched beyond its straining limit and the part damaged beyond use. In this situation, a like evaluation is made to predetermine a preform shape that is a deformation precursor shape of the final article shape. This predetermination step further includes determining whether the highest strain region(s) in the preform shape can be quickly annealed so that the preform shape can be stamped one more time into the final article shape. When it is determined that the aluminum alloy can be made by the claimed invention, tools can be made and the practice used to manufacture panels or other articles containing local, highly strained shapes.

Claims 1 and 13 also provide a commercially acceptable stamping sequence in that stamping and anneal steps are accomplished in like time periods.

It is respectfully submitted that the combination of the Krajewski et al. US Patent 6,038,911 (hereafter Krajewski for brevity) and the Biondich US Patent 5,776,270 (hereafter Biondich) do not render obvious the invention of claims 1-14.

Krajewski states that his "anti-intrusion barrier is formed from a corrugated piece of sheet metal, preferably formed by stamping ..." Figures 3 and 4 show end views of his corrugated sheet metal. The corrugations are simply semi-circular in Figure 3 and elliptical in Figure 4. No one suggests that these corrugations contain highly strained or hard-to-form regions. The corrugated piece is then restrained between flat plates 90, 92 and flattened between flat compressive platens 86, 88 as illustrated in Figures 6A-6D. Krajewski does not describe his corrugations as including any highly strained region. Indeed, an advantage of the Krajewski intrusion barrier is that it is easily made by stamping uniform arcs in a strip of metal and then simply flattening the arcs.

There is absolutely nothing in the Krajewski disclosure that helps a stamping engineer confronted with making an article shape that cannot be formed in a single stamping operation. Krajewski provides no teaching for analyzing a shape to be stamped, together with the stress/strain forming properties of a blank sheet material, to predetermine a preform shape that is designed to be a deformation precursor of a final article shape. Krajewski provides no insight in predetermining a preform shape with regions intentionally strained up to, but not exceeding, the straining limit of its material. And there is nothing in the Krajewski disclosure that would lead one skilled in the stamping art to the Biondich disclosure pertaining to the radial expansion of previously drawn and ironed aluminum cans.

Biondich has no disclosure pertaining to the stamping of sheet metal blanks into body panels. He starts with preformed cans and pushes out the side walls. Biondich does not use a punch and complementary forming surface to make stamped panels having a thickness of about one to three millimeters. Nor does Biondich predetermine how to make a stamped preform of sheet material and a finished sheet metal article with an intermediate anneal in processing steps of like duration. The only "predetermination" step suggested by Biondich is to select a can sidewall thickness to maximize its expansion.

Biondich discloses methods of expanding the sidewalls of drawn and ironed aluminum cans with intermediate annealing steps. He states (col. 4, line 54 and following) that suitable aluminum can bodies have wall thicknesses of 0.003 to 0.012 inch (0.08 mm to 0.31 mm). Biondich discloses that his expansion steps may be performed by electromagnetic forming or by a "conventional process" such as pneumatic, hydraulic, mechanical, elastomeric, explosive, and spin forming techniques. Three or more expansion steps are contemplated (col. 8, lines 13-27). Biondich does not expand his cylindrical cans by straining metal between a punch and a forming surface tool. There is no correlation between this disclosure and the metal stamping industry to which applicant's claimed invention applies.

The focus of Biondich's disclosure is in the use of electromagnetic force (EMF) forming. EMF forming is known for very high strain rate forming of very thin metal layers. Indeed, Biondich uses EMF to expand side walls of drawn and ironed cans having wall thicknesses of only about 0.08 mm to about 0.31mm which are much thinner than sheet metal blanks used in metal stamping. Electromagnetic forming does not use a punch and complementary forming surface in straining the metal. As described, EMF applies a uniform expansion force on the walls of the can, which presents entirely different metal forming issues than are encountered in the sheet metal stamping of claims 1-14. The electrical current induced in the thin aluminum can walls creates a magnetic field that is opposed by the magnetic field of the EMF generating fixture. At col. 8, Biondich discloses that the opposing fields act "almost instantaneously" to induce extremely high strain rates in the thin walls of his metal cans. The Biondich disclosure does not relate to metal stamping in which sheet metal is strained non-uniformly between a punch and a forming surface in a regime of friction and strain rates that differ from EMF.

Biondich does not disclose any strategy in the conduct of his expansion steps other than varying the thickness of the walls of the cans. He does not describe any practice in his expansion methods that relate to the "predetermination" steps of applicants claims 1 and 13. Biondich does not evaluate a candidate shape to be stamped from aluminum alloy sheet material to determine whether it may be stamped in a single step. Biondich does not predetermine a stamped preform shape that includes at least one region that is strained up to, but not exceeding, the straining limit and an annealing process that will allow the final shape to be reached in a single stamping of the preform shape.

Neither Krajewski nor Biondich discloses a process pertaining to the stamping of aluminum alloy sheets using punch and forming surface tools, and neither reference contemplates the "predetermining" step to enable the two stamping step sequence of applicant's independent claims 1 and 13.

Accordingly, it is respectfully requested that the rejections of claim 1-14 be reconsidered and withdrawn and that these claims be allowed and the case passed to issue.

Respectfully Submitted,

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